

BUILDING WIRING DESIGN CHECKLIST EXPLANATION

Version 2.0
February 12, 2001

1. Statement that states 100% compliance with the following standards:

"This design shall completely follow KETS standards listed in the document 'KETS Building Wiring Standards version 2.0 dated 10/15/92 and the 'Building Wiring Design Checklist Explanation version 2.0 dated 02/12/01. The exceptions to this are..."

The Building Wiring Design Checklist Explanation document overrides any differences which may exist between it and the 'KETS Building Wiring Standards document.

2. Plenum Cable:

Plenum cable shall only be used in areas that require it. For example, Plenum cable is used in an open-air return false ceiling. However in Kentucky schools, this is rare. Some vendors are using plenum cable for the whole school whether it is needed or not. Since plenum cable is 3 to 4 times as expensive as PVC, it shall only be used where Kentucky Building Codes or other safety measures require it. In some cases facilities are retrofitted or upgraded to a status requiring plenum installations where previous non-plenum is currently installed. Please be aware of future facilities work. A statement must include evidence that future facilities had been researched and discussed with proper school, district and state authorities.

3. Maximum CAT 5 UTP Cable Lengths for this Project:

For an Ethernet environment the maximum segment limit from the hub port to a terminal device is 100m. The maximum network length with repeaters is 2500m. For Token Ring environment the maximum lobe distance (operating at 16Mbps) is 60m. This means the distance from the MAU to the node must be no longer than 60 meters. Special media filters, active nodes or special hubs could retime, resync and rebroadcast. This could extend the allowable distance to 100m. Ensure you have purchased or planned for these active network extensions before you install your token ring environment. Token ring can also be extended to 2500m with repeaters. Plan that at least 3m- 5m will be used from the faceplate to the workstation.

4. Backbone Distribution Data, Voice and Video:

Shall use at least 6-strand 62.5u/125.5u multi-mode fiber for data, Cat 5 UTP cable with Amp 50-pin connector for voice, RG-6 with N-type connector for Video. In some cases single-mode fiber is required. Where this is the case please identify the situation, circumstances and requirements.

5. Horizontal and Vertical Distribution for Data, Voice and Video Cable:

Vendor shall use CAT 5 UTP (4-pair) 22/24 AWG cable with RJ-45 connectors at faceplate for data and voice. The termination of the wires within the RJ45 connector shall follow EIA/TIA 568A or 568B standards for termination. Shall use RG 59 broadband coaxial with F-type connector at faceplate for video. There shall be extra cable coiled up next to faceplate and 15 to 20 extra feet coiled at the DF. In all cases standards consistency must be maintained. For example: If a facility is currently partially cabled with EIA/TIA 568A this same standard must be maintained throughout the facility with new installations. Please include a statement showing evidence of consistence with addition wiring in buildings.

6. Horizontal/Vertical Distribution:

The preferred distribution method shall be the zone technique as opposed to Freestyle. Zone means there are large groups of wire bundled together (e.g. cable trays, J hooks, etc) that is extended throughout the building. Freestyle looks like a spider web where cable is extended individually or in very small groups from a centrally located MDF

7. Ceiling and under floor Horizontal distribution:

The vendor shall describe in detail their approach and their justification for that approach to the district:

Approach #1:

The main feeders should be square ducts, raceways or 2ft ceiling ladders. For a main feeder, there should be pull and splice boxes every 3 to 6m. Conduit should not be used as a main feeder device. Supporting feeders to the main feeder should be metal or plenum hard plastic conduit. If conduit and feeder trays are used then an electrical wire feeder tape can be used to easily and inexpensively install new cable or replace worn or defective cable. This option will be more expensive to install than other methods, but will replace itself in maintenance savings over the life of the cable system. This is because the labor required to install new cable or replace defective cable will be less. Reduced labor equals reduced cost. Having UTP in metal conduit also protects it from EMI.

Approach #2:

Devices like J hooks, single bar supports, O-Rings, and Bridals are discouraged because long-term support and maintenance is more difficult. These devices are acceptable if all the voice (1 line for every classroom) and data (1 for every 6 students, 1 for every classroom, 2 for administrators) cable is being installed at the same time in older facilities where cable and ladder trays are cost prohibitive. Otherwise every time a new data or voice line needs to be installed someone is going to have to physically return and weave/secure the new cable every 3 to 6 feet. The labor for this in the long run is time consuming and expensive. This approach also leaves the cable susceptible to EMI. Make sure initially and over time that your electrical contractors are aware of the location of your voice/data cables. Otherwise you will experience many transmission problems. For all NEW installations devices like J hooks, single bar supports, O-Rings, and Bridals are prohibited.

Approach #3:

Approach #3 would be a combination of approaches 1 and 2.

Older building may require retrofitting using molding that attaches to Crown, Baseboard, or Flank of a room. The tubing, raceways and power poles should have metal separators for power and communication/data lines. 90 degree bends should use curved conduit for UTP. Fiber should have no more than a five-inch bend throughout its run.

8. Riser Access:

Between floors from the MDF to IDF or IDF to IDF shall use Sleeves 10 to 20cm diameter, Slots/Cores, or Conduit 20 cm diameter.

9. Main Feeders:

All Main feeders shall be designed to handle the weight and physical capacity of another 50%.

10. For Building to Building (Campus) UTP or Fiber wiring:

Option 1:

Shall use environmental Aerial Cable: Clearly marked for physical protection, Special grounding and lightening protection (designed for outdoors) must be installed, tested and guaranteed in writing to meet or exceed all federal, state and local standards applying to lightening protection and installation of aerial fiber optics.

Option 2:

Conduit: Metal, PVC, or ABS 4" to 6" in diameter, encased in concrete or other protective material (gravel), .5m below ground surface.

Option 3:

None or Not applicable

Describe which option you are using in detail and why:

11. Data Lines to a Room:

The average classroom serves 18 students and 1 teacher.

For the classroom:

According to House Bill 698, every classroom shall have at least one Video, one voice, and one data cable terminated at a faceplate for the teacher. These are resources the teacher may use for instruction and daily operations. It is 100% standard that the student data cables be home runs from the MDF or IDF to a separate faceplate

For the student:

Student data lines may be installed in classrooms, libraries, or other places the district/school requires them. The number of student data lines depends on the District's Phase I UNMET need as described in the Master Plan for Education Technology or further maintenance or implementation as described in KETS Phase2 Master Plan for Technology. The master plan(s) provides funds for 1 data line for every 6 students, plus 50%. This additional 50% is included for installation in locations other than classrooms. This allows for cables to operate Labs, libraries, media centers, and other facilities intended for student use outside the traditional classroom environment. If a district wants to install more lines than this, 100% local funds must be used for the number of lines installed in excess of the allowed number. It is strongly recommended that the student data cables be home runs from the MDF or IDF to a separate faceplate. If the vendor does not follow this home run recommendation, then they shall explain the reason(s) in detail.

For School Administrators:

The master plan provides funds for 2 school administrator data cables per school. Any additional school administrator data cables must be paid for with 100% local funds. It is strongly recommended that the school administrator data cables be home runs from the MDF or IDF to a separate faceplate. If the vendor does not follow this home run recommendation, then they shall explain the reason(s) in detail.

For District Office Administrators:

The master plan provides funds for data cables be run for an average of 4 per District Office. The District Technology Coordinator can tell you their allotment. Any additional District Office administrator data cables must be paid for with 100% local funds. It is strongly recommended that the District Office

administrator data cables be home runs from the MDF or IDF to a separate faceplate. If the vendor does not follow this home run recommendation, then they shall explain the reason(s) in detail.

It is possible to install one data cable from the DF that connects to a concentrator in the classroom. This approach is highly discouraged because it forces the sacrifice of all major advantages attributable to centralized network management and maintenance. This approach also creates a bottleneck causing severely restricted availability of bandwidth for all workstations in the classroom in question. If this concentrator is an unintelligent or non-manageable device, then its next network connection shall be to an intelligent hub-switching hub in the DF.

12. Floor Conduit Size:

If conduit is used, it shall range from 1 to 5 inches for feeder cable. (A 1-inch conduit may carry up to 6 four pair cables (24AWG) and a 3-inch conduit may carry up to 30 cables.)

13. Drilling through walls or support structures:

Drilling through walls or support structures to install cable can quickly weaken a building's structure. The vendor shall describe any places they will be changing the support strength of a structure. They shall consult a licensed construction or civil engineer before using poke through techniques. They shall ensure proper safety measures are taken and the Kentucky Building Codes are followed.

14. Power considerations:

Education Technology Funds will not be used for power design but the Districts, Designers, and Installers shall consider the following:

Power circuits should be dedicated. When this is not possible power outlets should be isolated from receptacles that will be used for air conditioners, heating, refrigerators, drink machines, power tools, vacuuming, buffing, and maintenance shops. There should be a 20-amp circuit for every 5 workstations and related equipment. Quadruple receptacles. Surge protectors in circuit box for new construction and surge strips for existing systems. Receptacle should be no farther than 5 feet from proposed workstation location. Receptacle should be no farther than 1 foot from faceplate for data ports.

For CDF, MDF, IDF, SDF locations 1 dedicated 20-amp, 110-volt circuit is recommended for each equipment rack or equipment group.

15. EMI considerations:

Each inch of UTP shall be installed the following distances from EMI sources:

Fluorescent or neon lights	12inches or more
Power lines rated at less than 2kva	5 inches or more*
Power lines rated at more than 2KVA	39 inches or more
Transformers and motors	39 inches or more

*UTP may be installed within 5 inches of power lines rated at less than 2kva, providing both are installed in a raceway or conduit that provides physical separation between them. This means that the two are not to be allowed to physically come in contact with each other at any point in the run.

16. Distribution Frame (DF) Characteristics:

The vendor shall describe how their design/install shall address the following concerns:

Location:

A: CDF (Campus Distribution Frame), centralized location between buildings. Can be located in a separate, dedicated CDF building, a tunnel, or within the central MDF.

B: MDF (Main Distribution Frame), centralized location within a building located in a manner that maximizes efficient layout of 100m/60m UTP runs. Houses Cross connects, PBX, Communications Equipment and LAN Equipment.

C: IDF (Intermediate Distribution Frame).

In a multiple floor structure, DF's should be located directly above each other where possible. This allows for greatest simplicity in routing cables between, as well as promoting ease of maintenance in the future. In multiple floor structures, IDF's are often used mainly for Cross-connects, and small communications components

In single floor structures, an IDF is used when cables originating in the MDF cannot reach (goes beyond 100m) every workstation. An IDF shall be connected by Fiber to the MDF.

D: SIZE of CDF, MDF, and IDF:

For new buildings:

A CDF should contain 200 to 250 square feet of floor space. An MDF should contain 100 square feet.

An MDF should contain 150 square feet when the room is to be shared with file servers, computers, telephone switches, and equipment racks (PBXs, Audio/Video distribution systems, etc...)

An IDF should contain a wall space of at least 3' X 8' (only punch down blocks).

For existing building:

Should follow as close to the above specs as possible.

E: OTHER CHARACTERISTICS

Cross-connect access:

The primary function of any DF is to house appropriate cross-connect equipment to support the building wiring system.

Communications equipment:

A DF must be capable of supporting communications-related equipment, such as modems and communications servers.

Control equipment:

A DF can include control equipment, such as security devices, if the devices use the telecommunications wiring system within the building.

Some of the functions that a DF must never be used for include the following:

a. Power equipment:

The DF should never house power equipment unless it is directly related to the operation of the housed communications equipment.

b. Environmental equipment:

Unless special A/C for communications equipment is required, there should never be any form of environmental control equipment present.

c. Storage facilities:

Many DF rooms end up cluttered with excess equipment or non-communications-related items. A DF must be kept clean and orderly.

d. Non-telecommunications usage:

A DF should be limited in its use for non-telecommunications functions, such as the DF/office, the DF/coat-room, and the ever-popular DF/rest room (which has happened before).

17. Distribution Frame Equipment:

A DF will usually contain a fixed set of equipment. The vendor shall describe how the design/install addresses the following concerns:

Access point:

Each DF will have a single (usually) location where main distribution or TELCO cables enter the room.

Cross-connect blocks:

There shall be multiple sets of cross-connect blocks used to terminate incoming and outgoing cable.

Patch panels:

Patch panels, providing modularity between cabling and communications systems, have become a mainstay within most DF rooms.

Distribution hardware:

There will be miscellaneous equipment such as cable guides or raceways used to route cabling within the DF room.

Networking equipment:

It is not uncommon to find networking-related equipment within a DF. This includes modems, multiplexers, and local area network (LAN) hubs.

Communications power supplies:

Many high-usage communications devices will require an uninterrupted power supply (UPS) to filter power and provide emergency power in case of failure. Additionally, many newer communications devices require special power (i.e., non-110 V or conditioned) to operate.

Line protection:

Most DF rooms will require line protection on all incoming circuits. This protection will help protect end-user and centralized equipment from power or lightning surges that could result in equipment loss or accidental fires.

18. Distribution Frame Room:

The vendor shall describe how their design/install addresses the following concerns:

Single-use facility:

The DF room should be dedicated to communications functions. There shall not be any equipment present that is not directly related to telecommunications (i.e., HVAC ducts, steam or water pipes, electrical cabling).

Security:

Each DF room should be secure with locking doors and limited access through windows (windows should never exist in a DF room).

Access:

Each DF room shall have adequate doorway access to enable the installation of communications equipment.

Dedicated (clean) power:

Each DF room shall have dedicated power circuits unique to communications support. This will help to prolong the life of any power consuming communications equipment placed within the DF.

Common power:

In addition to a dedicated power supply, each DF room shall have an adequate supply of common power outlets for use by maintenance personnel during equipment installation or maintenance (i.e., power tools, exhaust fans).

Grounding system:

Each DF room shall have an approved isolated building ground (common within a building). The ground must be easily accessible with 6AWG cable support.

Tiled flooring:

A DF room shall always have an unfinished concrete (painted) or tiled floor. Carpeted floors are discouraged. Although some designers advocate the use of antistatic carpets, these carpets tend to be expensive, (they have metal grounding coils running through them) and difficult to clean. DF rooms tend to have a great deal of cable clippings on the floor. It is much easier to sweep an unfinished floor than it is to vacuum a carpeted floor (not to mention the electromagnetic interference to your data/voice communications a vacuum causes while in use).

Structural support:

A DF room should be able to support a minimum of 50 psi. This is very important for larger facilities that may house power or large private branch exchange (PBX) or computer equipment.

Non-drop ceiling:

Drop-tile, or suspended, ceilings should not be used within the DF. It is preferable to have direct floor-above access.

Fire protection:

Any room used for housing DF facilities shall have adequate fire prevention and protection systems in place. This will ensure that damage to telecommunications equipment during a fire will be kept to a minimum. Also note that many control systems (security, fire alarms, etc.) that depend upon electronic communications may have cross-connects located within, or may pass through, a DF facility. Additionally, all finished walls within a DF room shall be painted white with a flame-retardant paint. Every DF shall have some form of fire-suppression device in adherence to all Federal, State and Local laws and ordinances.

Environmental control:

Any DF room should maintain a minimum set of environmental parameters. Temperature should be maintained between 10 and 30 degrees C (50 to 85 degrees F) with a non-condensing humidity level of less than 65 to 70 percent. Higher humidity levels can result in corrosion of cross-connect equipment. Temperatures higher, or lower, than the acceptable range can result in improper operation of communications equipment.

Grounding:

It is important for any DF facility to have access to a proper building ground. There should be a single common ground, isolated from any other function. The ground should support access via 6AWG properly bonded cable. All electrical (low or high voltage) systems should be connected to a common ground to decrease the possibility of voltage differences (difference of potential) between service types. All grounding must follow 100% of all federal, state and local laws regulations and ordinances.

Cold Water pipes:

This provides the easiest, lowest-cost, and possibly most-effective source of building grounding. This requires access to a cold water pipe, constructed entirely out of steel that has a minimum soil penetration, without breakage, of at least 3m. The pipe should also be located at least 2 to 3 m below ground level.

Buried grounds:

A buried ground is a large piece of conductive metal that has been buried in open soil. This steel ground may consist of rods, plates, or coils. The size or length of the buried ground will depend upon the type, shape, and thickness of the metal being used (consult an appropriate electrical engineer for exact information on grounding requirements). It is not recommended this be a source of grounding unless a part of the common grounding system for a facility. All electrical (low or high voltage) systems should be connected to a common ground to decrease the possibility of voltage differences (difference of potential) between service types.

Building steel:

It is possible, in some cases, to use the building steel infrastructure as an acceptable ground.

19. Mounting Equipment:

The vendor shall describe how their design/install addresses the following concerns:

All cross-connect equipment shall be either wall-or rack-mounted. Wall-mounted equipment shall be mounted on 3/4-in plywood backboards measuring 4 by 8 ft. The plywood shall be horizontally hung with the bottom of the plywood approximately 0.5 m from the floor and to within 0.5 m of every wall (it is good practice to place plywood backboards on every wall within a DF room). If walls of the DF room extend above 3 m, the backboards may be hung vertically; however, no cross-connect or communications equipment shall ever be placed higher than 2 m off the ground. The plywood shall always be painted with a flame-retardant paint; no backboard should ever be left untreated. In no case shall any cross-connect

block or communications component, be installed directly onto a DF room wall, including drywall, concrete, or plywood.

20. Block Alignment:

The vendor shall describe how their design/install addresses the following concerns:

A structured approach to cross-connect block alignment is required in all DF rooms. By convention, voice blocks are mounted above all other blocks, including data and video equipment. Mounting shall be consistent in this fashion. While the vertical alignment separates cross-connect blocks by voice and data affiliation, the lateral configuration separates blocks from incoming and outgoing distribution systems. This vertical and horizontal separation of equipment may vary depending upon the type of media being used. For example, fiber-optic equipment-usually dedicated to data applications is typically housed alongside of twisted-pair voice applications and not underneath as twisted-pair data cross-connect blocks would be located.

All wall-mounted cross-connects shall be mounted on a single wall if possible. There shall be installed one duplex power outlet for each three backboards installed.

All riser cables shall be located in one area, preferably in the corner. Horizontal distribution shall be near the riser cables. Cable shall never enter a room in the middle of a wall. This can force segmentation and will make a structured approach to cross- connect design difficult.

21. Connect Block:

Level 5 wires from the faceplate shall lead to a 110 connect block and Terminate there. In rare cases, termination for data may occur at a concentrator if a School is extremely small (less than 30 students in the entire school).

22. Cable labeling:

A. Face Plates and the inside of box to which the faceplate is attached shall be marked as voice, data, and video. The room number shall also be written within the box.

B. Horizontal and vertical cable shall be labeled within 6 inches from the faceplate and 12 inches from the distribution rack. Shall be labeled with the room destination of the cable and the distribution frame name. The type of circuit (data, voice, or video) shall be identified by a label or color codes (e.g. red=data, blue=voice, green=video).

C. The cross-connect block, patch panel, and splice point shall be clearly marked with a unique identifier.

D. Labels shall be machine generated, self-laminating and viewable from 360 degrees. Flag type markers may not be used.

E. Patch cords greater than 2 feet in length shall have a label on each end.

23. Testing Activities:

The vendor shall describe how their design/install addresses the following concerns:

The following is a list of testing procedures that shall be adhered to for inspecting and testing the distribution hardware:

Structural tests:

The physical distribution system shall be tested for structural integrity (support capabilities) prior to any cable being installed.

Proper labeling:

An inspection shall be performed to ensure that the physical hardware is clearly labeled as telecommunications related.

Hardware inspection:

The entire system, including junction and pull boxes, should be visually inspected for any of the following environmental damage, rust, improper fittings, rough edges, excess moisture, and contact with other systems (electrical, security, etc...) where appropriate.

Grounding:

The system shall be checked for proper grounding, where appropriate.

Fire-stopping:

Any fire-stopping seals shall be carefully inspected. This includes any areas that have been sealed with any material for non-fire-stopping purposes as well.

Faceplate connection:

The connection point between the faceplate and the distribution hardware shall be carefully inspected to ensure that the connection is both properly fitted and that the distribution hardware does not prevent the faceplate outlet box from properly attaching to the supporting structure (wall, floor, ceiling, power pole, etc.).

The following is a list of procedures for inspecting and testing the horizontal distribution cable after installation:

Junction inspection:

Each junction box shall be inspected (where possible) to determine if cables have been scraped against any surface. Look for sheath shavings.

Faceplate inspection:

There shall be ample spare cable beyond the end of the distribution hardware to allow for simplified installation and later re-termination if required. The spare cable can be coiled within the distribution hardware or the housing structure (i.e., in the drywall).

Continuity testing:

Cables shall be tested end to end for signal continuity. This is accomplished with either a tone tester or a proper polarity tester. While these both check for signal continuity, the polarity test is preferred since the tone test can give misleading results, due to signal strength, between multiple pairs of cable. For example, a tone being sent down one conductor can often be detected on other conductors because of crosstalk signals. Another method of testing the cable involves the use of a time-delay-reflectometer (TDR), which sends a signal down the cable. By measuring the delay in the signal reflection (and the waveform of the reflection), the TDR can determine how long the cable is and if there are any short or

open points along the circuit. This can also be used to test the electrical characteristics (including background EMI noise) of a copper cable. Fiber-optic cables should be tested for both signal integrity and signal strength (i.e., dB loss) with an optical TDR (OTDR).

24. Documentation:

The vendor shall provide each of the following to the client within 60 days of completing the installation:

- A. Final As-built drawings showing the location of each network device and the route of each cable.
- B. Materials and components listing for each item such as manufacture, part #, and distributor.
- C. Patching Map. A visual aid that is located on or near the patch panel. Shows device or cable connected to each patch panel position.
- D. Notebook size drawing of facility rooms with network active/passive layout from faceplate to distribution frames.

25. Qualified Designers:

Vendor must be a Registered Communications Distribution Designer or show other certifications the designer has that ensure they are competent to do this kind of work. Just because they know how to install one kind of cable (electrical, voice) is no guarantee they are technically skilled on installing another type (data).

Other Considerations:

The vendor shall describe how their design/install addresses the following concerns:

A: Installation Scheduling:

Hardware installation:

Hardware shall be installed only after the building exterior is completed and the risk of damage to the system by adverse weather conditions has been eliminated. This may not seem a major problem; however, excess water in a conduit or duct system can alter the electrical characteristics of cable placed within the hardware. In any event, only rust-resistant metal should be used.

Ceiling installation:

Ceiling distribution systems shall be installed prior to ceiling tiles being installed.

Conduit and duct installation:

Any conduit or duct system installed within a wall (i.e., feeder conduit between a main duct and an faceplate unit) shall be installed prior to the drywall installation.

Under carpet installation:

Under carpet cabling shall only be installed after the building interior is fully completed. This type of system is easily installed after carpeting has been put in place (assuming that removable carpet tiles have been installed rather than single-piece or glued carpet).

Under floor installation:

All under floor ducts shall be installed during the floor pouring process. This may seem a bit obvious, but it is surprising the number of telecommunications personnel who inquire after a building has been occupied if they can bore holes into concrete floors for conduit or duct. This also applies to trenches that are inset into concrete floors. Although it is possible to cut trenches into established concrete floors, it is often expensive or prohibited because of structural support requirements.

B: Cable access:

Any distribution hardware shall provide sufficient clearance (Greater than 2 feet) into any DF to provide adequate access to cable installers. The exception to this is conduit, which should be terminated within 1 ft of the entrance unless the conduit must reach a specific room or frame location prior to termination.

C: Hardware finishing:

After the installation of any hardware system, all rough edges, such as a connector or pull box joints, shall be filed, de-burred, or covered with plastic coating (plenum-rated if required). Smooth grommets should be installed in any location where cable must pass through rough-cut metal, such as the entrance into a duct system or where cable may pass through metal studs or partitions. Failure to install these grommets can result in cuts into cables, which can sever a conductor and/or diminish performance characteristics.

D: Labeling:

All telecommunications-related hardware shall be clearly labeled as such and be free from any unauthorized cable or equipment (it is surprising how many A/C and power systems are tie-wrapped to telecommunications ladders or conduit for support).

E: Stress testing:

Any hardware installed in a ceiling shall be stress-tested to ensure the hardware is capable of supporting the maximum cable weight as specified by the hardware manufacturer (it is a good idea to add 25 or 50 percent to this weight, given the likelihood of system overloading and those surprise cases where the system must perform an unexpected function).

F: Equipment grounding:

Any metal distribution equipment should be properly grounded if it terminates/originates in any common distribution room (and if required by local, state, or federal building codes).

G: Installation timing:

Cable shall be installed only after the building exterior is complete, the distribution hardware has been completed and stress-tested, and the interior of the building completed to such a point where the risk of damage to the system due to adverse weather conditions has been eliminated.

H: Cable protection:

Any cable installed while building construction is still in progress shall be adequately protected. This includes cables left exposed during the installation process.